Assigment 3

This assigment focuses on getting comfortable with working with multidimensional data and linear regression. Key items include:

- Creating random n-dimensional data
- Creating a Model that can handle the data
- Plot a subset of the data along with the prediction
- Using a Dataset to read in and choose certain columns to produce a model
- Create several models from various combinations of columns
- Plot a few of the results
- BONUS: Perform all the plots in 3D instead of 2D

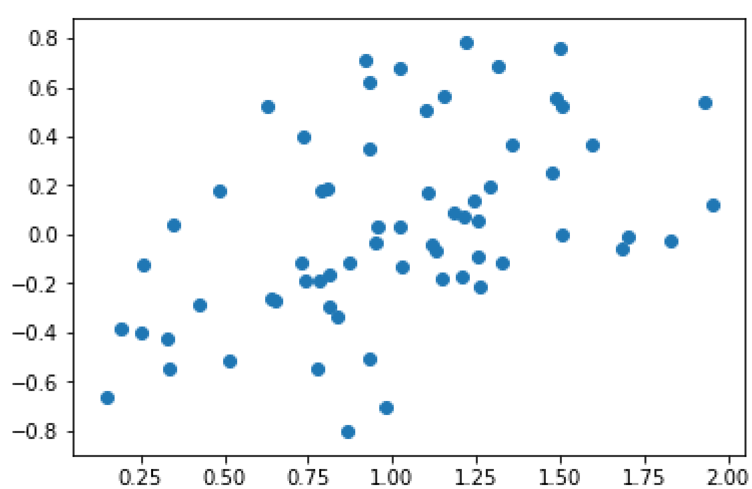
1. Create a 4 dimensional data set with 64 elements and show 2D plots of the data $x_1 \rightarrow y, x_2 \rightarrow y$, etc.

In [10]:
```
import numpy as np
import matplotlib.pylab as plt
%matplotlib inline
```

In [11]:
```
n = 64
x = np.linspace(0, 1, n) + np.random.rand(4, n)
x = np.vstack([x, np.ones(len(x.T))]).T
y = np.linspace(0, 1, n) + np.random.rand(n) - 1
```

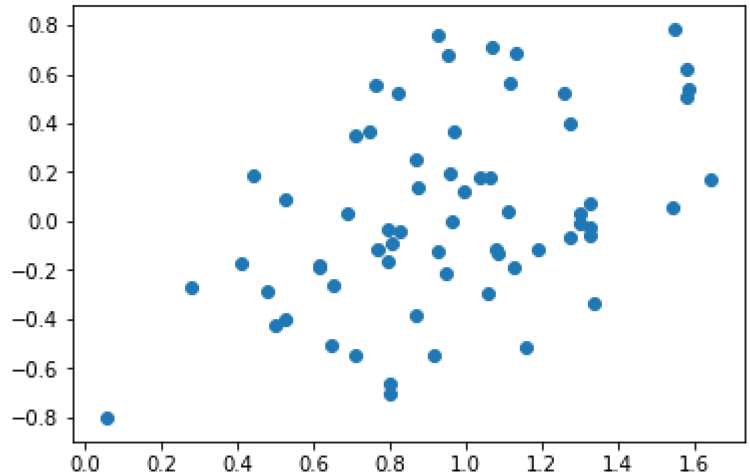
In [12]:
```
# x1→y
plt.scatter(x.T[0], y)
```

Out[12]: <matplotlib.collections.PathCollection at 0x108464e80>



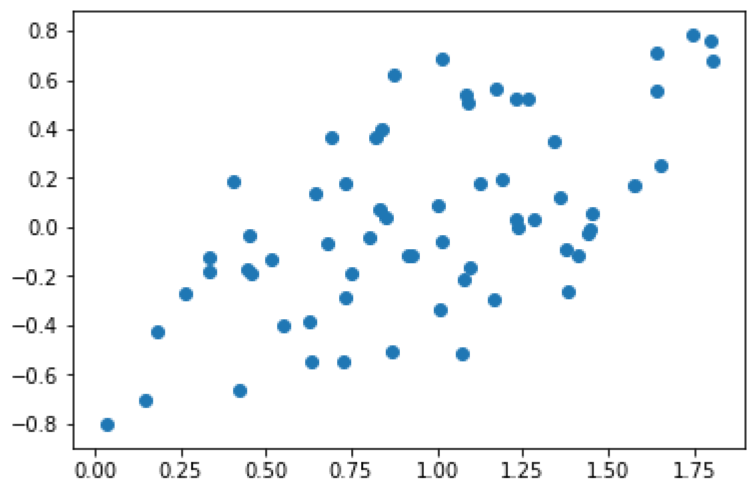
In [13]:
```
# x2→y
plt.scatter(x.T[1], y)
```

Out[13]: <matplotlib.collections.PathCollection at 0x108493cc0>



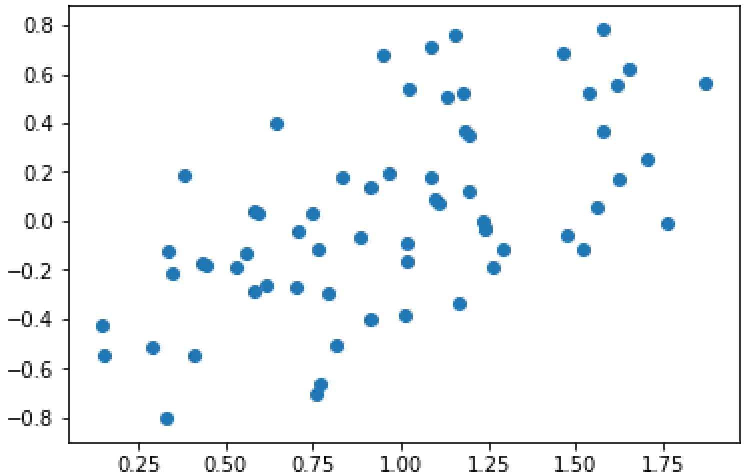
In [14]:
```
# x3→y
plt.scatter(x.T[2], y)
```

Out[14]: <matplotlib.collections.PathCollection at 0x10860de80>



In [15]:
```
# x4→y
plt.scatter(x.T[3], y)
```

Out[15]: <matplotlib.collections.PathCollection at 0x108714ac8>



2. Create a model to fit the data. Hint: follow the example from Lesson 3

$$\beta = (X^T X)^{-1} Y^T X$$

In [16]:
```
beta = np.linalg.lstsq(x, y)[0]
beta
```

Out[16]: array([0.11308905, 0.10051588, 0.30767816, 0.23822765, -0.71483096])

Model:

$$y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4$$

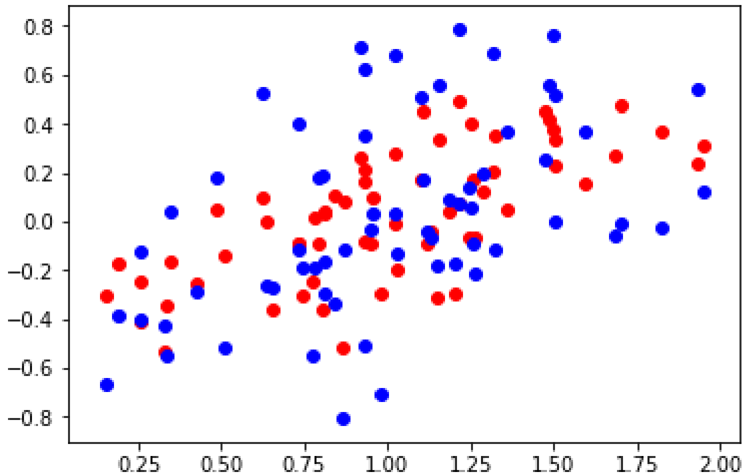
$$y = -0.813 + 0.0951 X_1 + 0.198 X_2 + 0.239 X_3 + 0$$

3. Plot the model's prediction in 2D for 2 of the dimensions ($x_1 \rightarrow y_p, x_2 \rightarrow y_p$) along with the original points

In [17]:
```
pred = np.dot(x, beta)
```

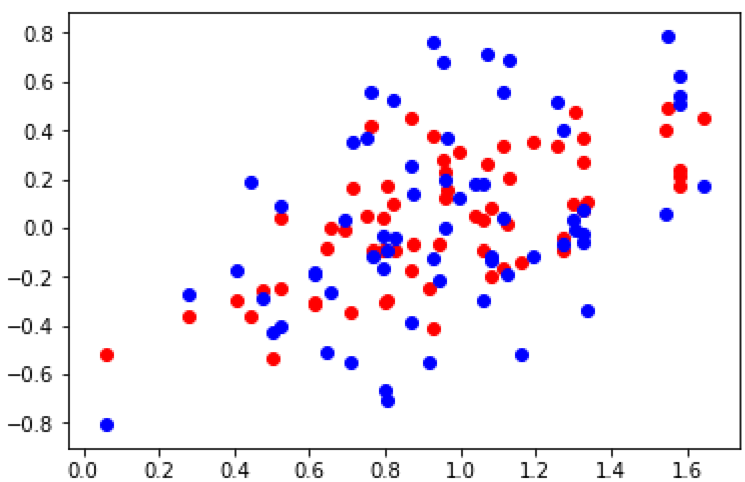
In [18]:
```
plt.scatter(x.T[0], pred, c='red')
plt.scatter(x.T[0], y, c='b')
```

Out[18]: <matplotlib.collections.PathCollection at 0x10871d5f8>



In [19]:
```
pred_1d = np.dot(x, beta)

plt.scatter(x.T[1], pred, c='red')
plt.scatter(x.T[1], y, c='b')
```

Out[19]: <matplotlib.collections.PathCollection at 0x1089c9fd0>



4. Read in `mlnn/data/Credit.csv` with Pandas and create a model to predict Credit Rating (`Rating`). Use only the numeric columns in your model, but feel free to experiment which which columns you believe are better predicters of Credit Rating

In [20]:
```
import numpy as np
import pandas as pd
import matplotlib.pylab as plt
%matplotlib inline
```

In [21]:
```
credit = pd.read_csv('../data/Credit.csv')
credit.head()
```

Out[21]:

	Unnamed: 0	Income	Limit	Rating	Cards	Age	Education	Gender	Student	Married	Ethi
0	1	14.891	3606	283	2	34	11	Male	No	Yes	Cau
1	2	106.025	6645	483	3	82	15	Female	Yes	Yes	Asia
2	3	104.593	7075	514	4	71	11	Male	No	No	Asia
3	4	148.924	9504	681	3	36	11	Female	No	No	Asia
4	5	55.882	4897	357	2	68	16	Male	No	Yes	Cau

In [84]:
```
# Set Y to Rating
y_credit = credit['Rating']
```

In [91]:
```
# Model 1: Income, Age
x_m1 = credit[['Income', 'Age']].as_matrix()

x_m1 = np.vstack([x_m1.T, np.ones(len(x_m1))]).T
x_m1
```

Out[91]:
```
array([[  14.891,   34.   ,    1.   ],
       [ 106.025,   82.   ,    1.   ],
       [ 104.593,   71.   ,    1.   ],
       ...,
       [  57.872,   67.   ,    1.   ],
       [  37.728,   44.   ,    1.   ],
       [  18.701,   64.   ,    1.   ]])
```

In [92]:
```
# Betas for Model 1
beta_m1 = np.linalg.lstsq(x_m1, y_credit)[0]
beta_m1
```

Out[92]:
```
array([   3.50245506,   -0.32939018,  214.89921532])
```

Model 1:

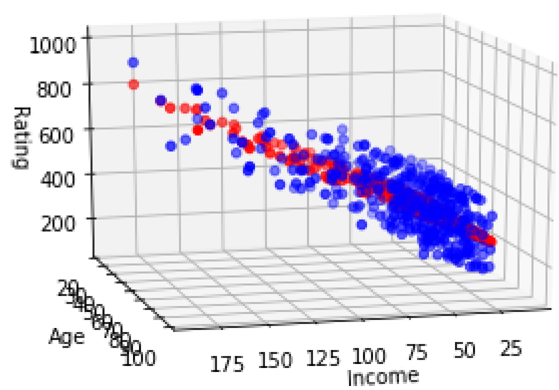
$$y = \beta_0 + \beta_1 X_1 + \beta_2 X_2$$

$$y = 214.899 + 3.502 X_1 - 0.329 X_2$$

In [94]:
```
# Predicted values for Model 1
pred_m1 = np.dot(x_m1, beta_m1)
```

In [96]:
```
# Model 1 Plot

import matplotlib.pyplot as plt
from mpl_toolkits.mplot3d import Axes3D

fig = plt.figure()
ax = fig.add_subplot(111, projection='3d')
ax.view_init(15, 75)
ax.scatter(x_m1.T[0], x_m1.T[1], pred_m1, zdir='z', c='r')
ax.scatter(x_m1.T[0], x_m1.T[1], y_credit, zdir='z', c='b')
ax.set_xlabel('Income')
ax.set_ylabel('Age')
ax.set_zlabel('Rating')
```

Out[96]: <matplotlib.text.Text at 0x10cd0c908>



In [97]:
```
# Model 2: Credit Limit, No. of Cards, Credit Balance
x_m2 = credit[['Limit','Balance']].as_matrix()

x_m2 = np.vstack([x_m2.T, np.ones(len(x_m2))]).T
x_m2
```

Out[97]:
```
array([[  3.60600000e+03,   3.33000000e+02,   1.00000000e+00],
       [  6.64500000e+03,   9.03000000e+02,   1.00000000e+00],
       [  7.07500000e+03,   5.80000000e+02,   1.00000000e+00],
       ...,
       [  4.17100000e+03,   1.38000000e+02,   1.00000000e+00],
       [  2.52500000e+03,   0.00000000e+00,   1.00000000e+00],
       [  5.52400000e+03,   9.66000000e+02,   1.00000000e+00]])
```

In [99]:
```
# Betas for Model 2
beta_m2 = np.linalg.lstsq(x_m2, y_credit)[0]
beta_m2
```

Out[99]:
```
array([  6.57875811e-02,   6.03409109e-03,   4.02585132e+01])
```

In [101]:
```
beta_m2_obj = beta_m2.astype(object)
beta_m2_obj
```

Out[101]:
```
array([0.06578758106490043, 0.006034091092188332, 40.258513229775915], dt
ype=object)
```

Model 2:

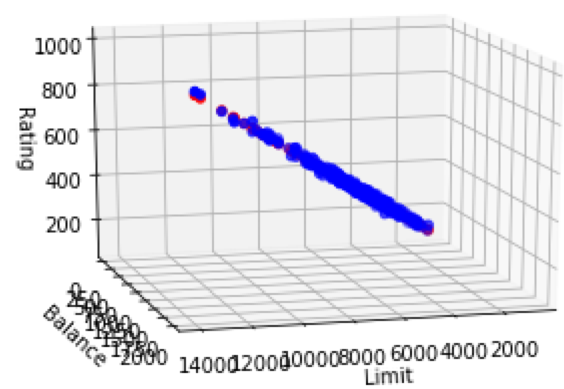
$$y = \beta_0 + \beta_1 X_1 + \beta_2 X_2$$

$$y = 40.258 + 0.0657X_1 - 0.00603X_2$$

In [106]:
```
# Predicted values for Model 2
pred_m2 = np.dot(x_m2, beta_m2)
```

In [107]:
```
# Model 2 Plot

fig = plt.figure()
ax = fig.add_subplot(111, projection='3d')
ax.view_init(15, 75)
ax.scatter(x_m2.T[0], x_m2.T[1], pred_m2, zdir='z', c='r')
ax.scatter(x_m2.T[0], x_m2.T[1], y_credit, zdir='z', c='b')
ax.set_xlabel('Limit')
ax.set_ylabel('Balance')
ax.set_zlabel('Rating')
```

Out[107]: <matplotlib.text.Text at 0x10d12eb00>



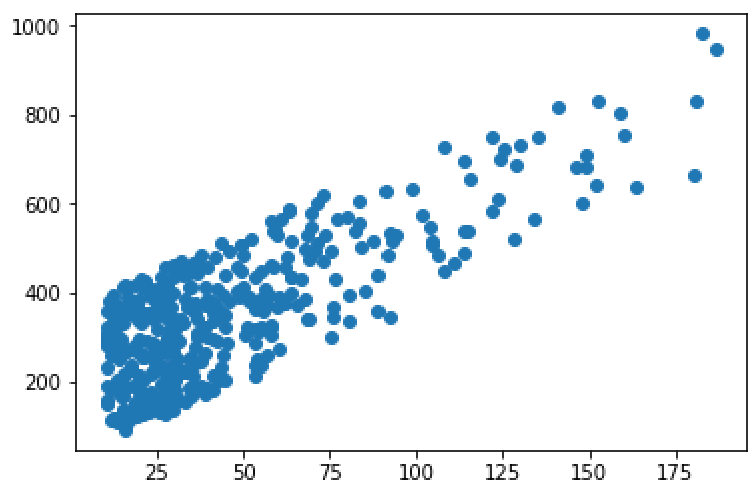
In [22]:
```
# Model 3: All numeric variables
x_credit = credit[['Income', 'Limit','Cards', 'Age', 'Education', 'Balance']

x_credit = np.vstack([x_credit.T, np.ones(len(x_credit))]).T
x_credit
```

Out[22]:
```
array([[  1.48910000e+01,   3.60600000e+03,   2.00000000e+00, ...,
          1.10000000e+01,   3.33000000e+02,   1.00000000e+00],
       [  1.06025000e+02,   6.64500000e+03,   3.00000000e+00, ...,
          1.50000000e+01,   9.03000000e+02,   1.00000000e+00],
       [  1.04593000e+02,   7.07500000e+03,   4.00000000e+00, ...,
          1.10000000e+01,   5.80000000e+02,   1.00000000e+00],
       ...,
       [  5.78720000e+01,   4.17100000e+03,   5.00000000e+00, ...,
          1.20000000e+01,   1.38000000e+02,   1.00000000e+00],
       [  3.77280000e+01,   2.52500000e+03,   1.00000000e+00, ...,
          1.30000000e+01,   0.00000000e+00,   1.00000000e+00],
       [  1.87010000e+01,   5.52400000e+03,   5.00000000e+00, ...,
          7.00000000e+00,   9.66000000e+02,   1.00000000e+00]])
```

In [23]:
```
y_credit = credit['Rating']
```

In [24]:
```
plt.scatter(x_credit.T[0], y_credit)
```

Out[24]:
```
<matplotlib.collections.PathCollection at 0x108b99c50>
```



In [25]:
```
beta_credit = np.linalg.lstsq(x_credit, y_credit)[0]
beta_credit
```

Out[25]:
```
array([  9.48157743e-02,   6.42304413e-02,   4.67706085e+00,
         8.06617460e-03,  -2.30863025e-01,   8.18115721e-03,
         3.10522106e+01])
```

In [26]:
```
beta_credit_obj = beta_credit.astype(object)
beta_credit_obj
```

Out[26]:
```
array([0.09481577432067419, 0.06423044130073922, 4.677060849762247,
       0.008066174598414378, -0.2308630248280594, 0.008181157210247932,
       31.052210560648014], dtype=object)
```

Model 3:

$$y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6$$

$$y = 31.052 + 0.0948 X_1 + 0.0642 X_2 + 4.677 X_3 + ($$
$$+ 0.00818 X_6$$

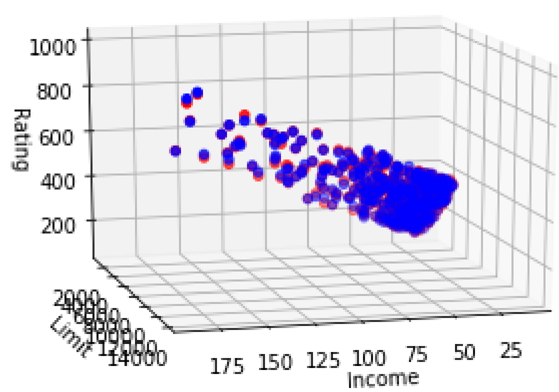
5. Plot your results (Bonus if you use 3D plots). Show as many of your columns vs. credit rating that you can.

In [82]:
```
pred_credit = np.dot(x_credit, beta_credit)
pred_credit[:5]
```

Out[82]:
```
array([ 273.8922873 ,  486.53358393,  516.88616875,  675.28737617,
        359.80395292])
```

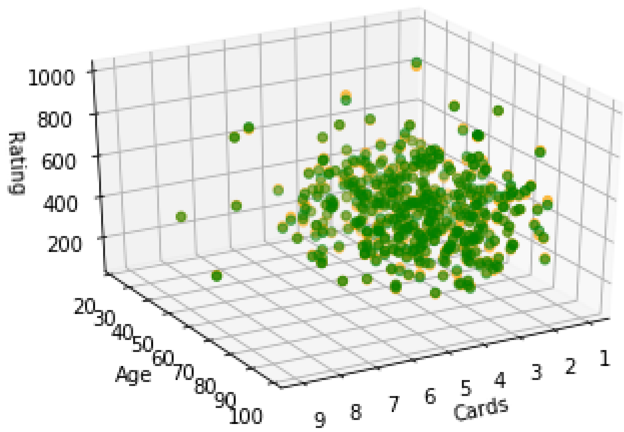
In [77]:
```
import matplotlib.pyplot as plt
from mpl_toolkits.mplot3d import Axes3D

fig = plt.figure()
ax = fig.add_subplot(111, projection='3d')
ax.view_init(15, 75)
ax.scatter(x_credit.T[0], x_credit.T[1], pred_credit, zdir='z', c='r')
ax.scatter(x_credit.T[0], x_credit.T[1], y_credit, zdir='z', c='b')
ax.set_xlabel('Income')
ax.set_ylabel('Limit')
ax.set_zlabel('Rating')
```

Out[77]:
```
<matplotlib.text.Text at 0x10c915828>
```



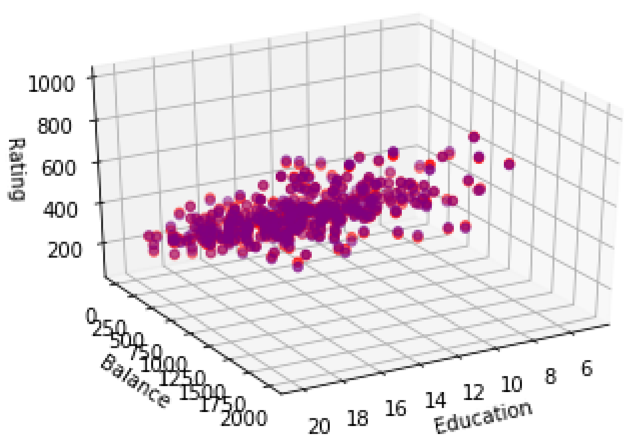
In [72]:
```
fig = plt.figure()
ax = fig.add_subplot(111, projection='3d')
ax.view_init(30, 60)
ax.scatter(x_credit.T[2], x_credit.T[3], pred_credit, zdir='z', c='orange')
ax.scatter(x_credit.T[2], x_credit.T[3], y_credit, zdir='z', c='green')
ax.set_xlabel('Cards')
ax.set_ylabel('Age')
ax.set_zlabel('Rating')
```

Out[72]: <matplotlib.text.Text at 0x10c340b70>



In [75]:
```
fig = plt.figure()
ax = fig.add_subplot(111, projection='3d')
ax.view_init(30, 60)
ax.scatter(x_credit.T[4], x_credit.T[5], pred_credit, zdir='z', c='red')
ax.scatter(x_credit.T[4], x_credit.T[5], y_credit, zdir='z', c='purple')
ax.set_xlabel('Education')
ax.set_ylabel('Balance')
ax.set_zlabel('Rating')
```

Out[75]: <matplotlib.text.Text at 0x10c724160>



In [ ]: